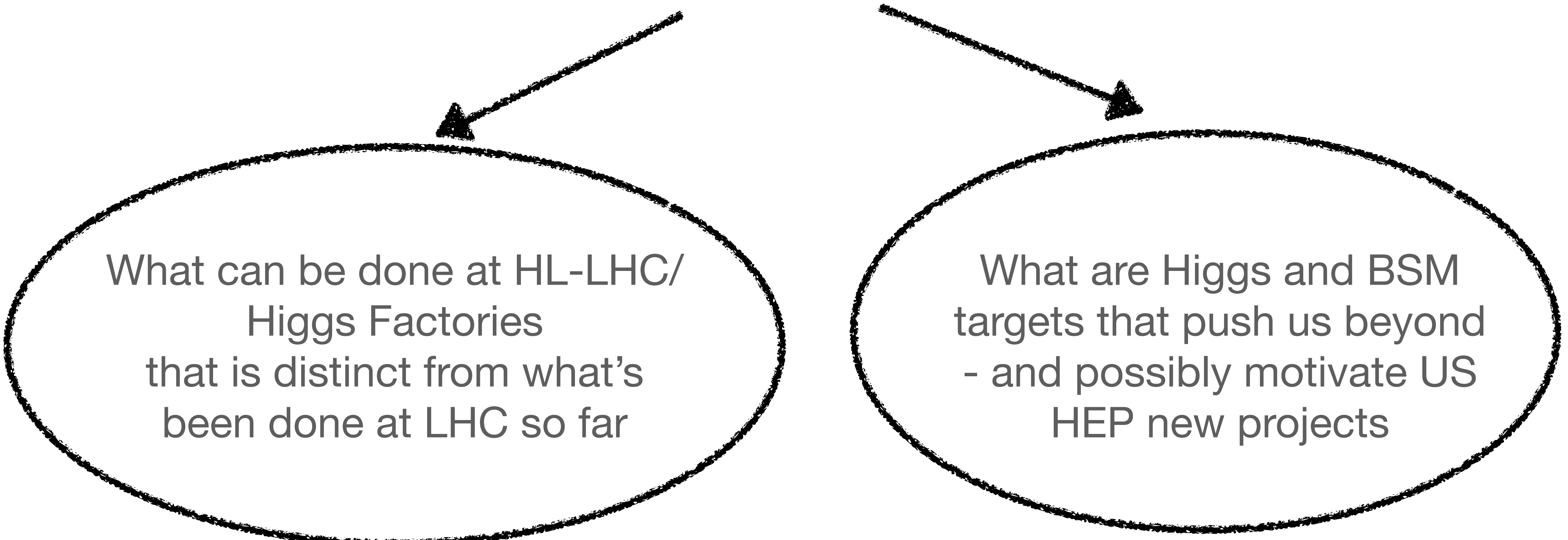


# **EF02 Topical Group Activities**

**Patrick Meade and Isobel Ojalvo (co-conveners)**

**July 22, 2020**

# Working group activities so far - 2 main focuses so far



What can be done at HL-LHC/  
Higgs Factories  
that is distinct from what's  
been done at LHC so far

What are Higgs and BSM  
targets that push us beyond  
- and possibly motivate US  
HEP new projects

Raman's talk in EF1-4 parallel session yesterday

# “Near Term Focus”

There are *still* several areas associated with Higgs where **BIG** deviations could show up

In particular - areas where little focus has gone thus far or measurements that are just hard

## Meetings on Higgs “friends” and Triple Higgs

Heinemeyer - standard 2HDMs consistent w/large triple Higgs

Egaña - 2HDMs beyond the standard NFC - largest di-Higgs cross sections available

Chang & Luty - Unitarity bounds on triple Higgs

Next meeting Aug 7 - Higgs and Flavor

# **“Long Term Focus”**

**Some slides from Raman’s talk yesterday and summarizing them**

# Basic Idea

- Standard approach
  - “Given” a collider - work out the what it can do
- Our approach
  - What are some of the theory questions we’d like to address
    - work out needed collider/experiments during Snowmass

# Subdividing what we've come up with so far

Three main categories with lots of overlap



# Complementarity with other Frontiers

While slow at the start, the energy frontier is ultimately needed to “win the race”



Nevertheless if we get indirect hints from existing  
or planned experiments its important to know how to test them!

Gravitational Waves, Astrophysics, Dark Matter, Rare Processes

# Summary and highlights from BSM “Wishlist”



Observable/ Physics Driver/ Complementary Frontier Experiments	Scale or Precision Needed
EW Phase Transition	$\delta\lambda_3 \ll 1\%$
Higgs and Flavor	$\delta(y_u, y_d, y_s, y_e) \lesssim \mathcal{O}(1)$
Compositeness- Mesotuning	KK scale 10-100 TeV
Supersymmetry/Dark Matter- Mini Split SUSY	Nail the simplest WIMP 3 TeV Wino WIMP DM Mini-split implies 30 TeV gluino
Neutral Naturalness	Probe SM charged partner states at 20 TeV (naively implying 300 TeV pp collider)
Gravitational Waves/Phase Transitions	1-10 PeV LIGO 100 GeV-Tev LISA
Electron EDM rapid improvement 2-3 orders of mag in next decade or so	1 PeV - electron flavored 50 TeV - Higgs or EW Barr-Zee
Charged Lepton Flavor Violation 4 orders of mag in mu to e by 2035	50 TeV 1 loop CLVF

# By providing aspirational targets

- It helps sharpen arguments for what can be seen and what needs calculated (BSM, SM, Formal theory crossovers)
- Since machines/detectors well beyond current scope are needed, it provides exciting R&D goals for both accelerator and experimental physics
- It can also help focus *existing* proposals to see if e.g. detectors can be proposed to address specific questions

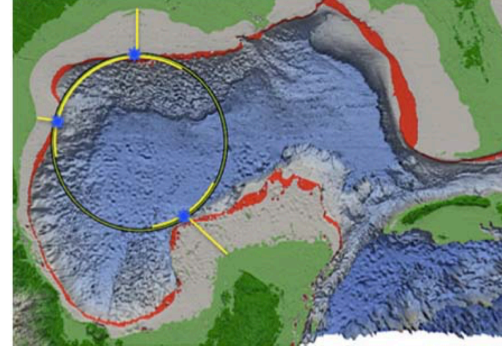


Figure 2: Bathymetry of the Gulf of Mexico, showing potential alignment of a 1,900 km circumference hadron

Collider in the Sea: Vision for a 500 TeV World Laboratory

?

Physics  
Potential

$\mu$ -collider e w/PWFA 30 TeV

FCC-hh/SPPC

$\mu$ -collider 14 TeV

CLIC

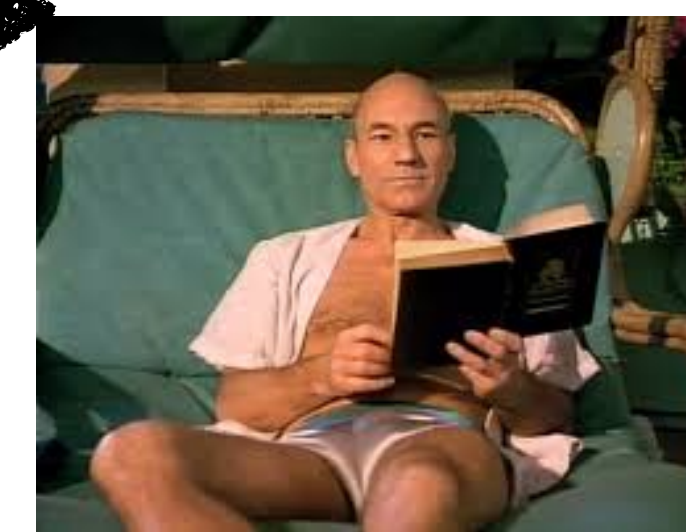
FCC-ee/CEPC

ILC

$\mu$ -collider 125



R&D attractiveness



# Where should we focus experimental R&D efforts?

Muon Cooling

Precision Timing Detectors

Streaming Readout

Wakefield Acceleration

AI and Machine Learning

Real-time Reconstruction

High Field Magnets

Radiation Tolerance

Object Reconstruction  
in high PU environments

What else?

# Where should we focus experimental R&D efforts?

Muon Cooling

Precision Timing Detectors

Streaming Readout

Wakefield Acceleration

AI and Machine Learning

Real-time Reconstruction

High Field Magnets

Radiation Tolerance

Object Reconstruction  
in high PU environments

What else?

Most of this is useful for any future experiment/collider!!



# Where should we focus experimental R&D efforts?

Muon Cooling

Precision Timing Detectors

Streaming Readout

Wakefield Acceleration

AI and Machine Learning

Real-time Reconstruction

High Field Magnets

Radiation Tolerance

Object Reconstruction  
in high PU environments

What else?

IF some technology takes 30 years to develop then we should start now!

# Plans for rest of Snowmass

Focus on the *near* future and *aspirational* dreaming!

For aspirational side -  
additional physics cases beyond those laid out in summary table coming soon in a document/LOI (Arkani-Hamed, Craig, Meade, Ojalvo, Reece, Sundrum)

In principle there are opportunities for US HEP - to think about its own projects!

# Building for Discovery

Strategic Plan for U.S. Particle Physics in the Global Context



**US HEP Energy Frontier -  
The reports of my death are greatly exaggerated.**

**Let's make sure this is true...**



# Plans for rest of Snowmass

Focus on the *near* future and *aspirational* dreaming!

For aspirational side -  
additional physics cases beyond those laid out in summary table coming soon in a document/LOI (Arkani-Hamed, Craig, Meade, Ojalvo, Reece, Sundrum)

In principle there are opportunities for US HEP - to think about its own projects!

For both near and far focus, there are *many* physics studies that need done  
whether HL-LHC scale or dream machines -  
**especially for young people who want to shape the future of their field!**